RESEARCH CIRCULAR 164 FEBRUARY 1969

Corn Silage in a Complete Ration for Dairy Calves

J. W. HIBBS

H. R. CONRAD

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio

CONTENTS

*

Corn Silage in a Complete Ration for Dairy Calves

J. W. HIBBS and H. R. CONRAD

INTRODUCTION

In previous experiments with complete rations for calves, ground and pelleted mixtures of 2 parts roughage and 1 part concentrate were studied (1, 2, 4, 5). Feeding these complete high-roughage pelleted rations resulted in faster growth than when loose hay and concentrate were previously fed in the same ration (6). When high-moisture alfalfa or legume-grass silage was fed instead of loose hay, calf growth was not satisfactory (3, 8, 9).

Because of the current widespread use of corn silage on dairy farms, it seemed timely to test the use of corn silage in a complete ration for calves. In previous experiments, conflicting results were obtained when growth was measured in calves fed corn silage (7, 10).

EXPERIMENTAL PROCEDURE

Holstein and Jersey calves which had been fed complete high-roughage pelleted rations to 16 weeks of age were fed either an experimental complete corn silage ration (64.1 percent concentrate) or a standard control, loose alfalfa hay ration (28.8 percent concentrate) for the 9-week period from 17 to 26 weeks of age.

Feed intake, body weight gain, and withers height gain were used as measures of performance.

The complete ration (7 parts wet corn silage and 1 part air dry concentrate) contained an average of 38.9 percent dry matter and consisted of the ingredients shown in the table below.

Estimated composition (based on Morrison's tables) of the complete ration on the dry matter basis was: 2.5 parts dry corn silage and 1 part

	As Fed (lb.)	Dry Matter (%)	As Fed (%)	Dry Basis (%)
Wet corn silage	700	31.9	87.50	71.73*
Ground shelled corn	46	88.0	5.75	13.00
Soybean meal	50	88.0	6.25	14.13
Bone meal	3	88.0	0.38	0.29
Salt	1	88.0	0.12	0.85
Total			100.00	100.00

*Includes approximately 35.8% corn kernels.

dry concentrate, 65.8 percent TDN, estimated net energy 70.2 therms per 100 lb., 10.5 percent digestible protein, 13.9 percent total protein, 0.59 percent calcium, and 0.44 percent phosphorus (Ca:P ratio = 1.34:1). The estimated nutritive ratio was 1:5.27.

Assuming that 50 percent of the corn silage dry matter was corn kernels and assigning this to the concentrate fraction, the roughage (stalk, leaves and cob) constituted 35.9 percent of the total ration and the concentrate 64.1 percent on a dry matter basis. This is a ratio of 1 part roughage to 1.79 parts concentrate.

The composition of the concentrate mixture (26.1 percent total protein) mixed with the silage to make the complete ration was: ground shelled corn, 46 percent; soybean meal, 50 percent; bone meal, 3 percent; and salt, 1 percent.

The wet corn silage was mixed with the concentrate mixture at feeding time and the mixture was fed free choice in the ratio of 7 parts of corn silage to 1 part of concentrate. The daily intake and refuse were recorded. Dry matter intake was estimated on the basis of weekly dry matter determinations on the silage and an assumed dry matter of 88 percent in the concentrate mixture.

The complete ration was fed to 14 Holstein calves and 8 Jersey calves. These calves were compared with a similar group of 16 Holsteins and 6 Jerseys fed the control ration.

The control ration contained an average dry matter ratio of 2.56 parts of good alfalfa hay to 1 part of a simplified concentrate mixture (18.8 percent total protein). The concentrate consisted of ground shelled corn, 50 percent; ground oats, 20 percent; soybean meal, 27 percent; bone meal, 2 percent; and salt, 1 percent.

Based on the average hay to concentrate dry matter ratio of 2.56:1 consumed by both Holsteins and Jerseys during the 9-week period, 17-26 weeks of age, the estimated composition of the control ration dry matter was: TDN, 59.3 percent; estimated net energy, 51.4 therms per 100 lb.; digestible protein, 12.8 percent; total protein, 17.1 percent; calcium, 1.02 percent; phosphorus, 0.33 percent (Ca:P = 3.09:1). The estimated nutritive ratio was 1:3.63.

The alfalfa hay was fed free choice with the concentrate restricted to a 2:1 hay to concentrate ratio up to a 4 lb. per day limit for Holsteins and a 3 lb. per day limit for Jerseys. Many of the calves exceeded either 8 lb. or 6 lb. of hay per day before 26 weeks of age, accounting for the 2.56:1 overall average ratio of hay to concentrate for both Holsteins and Jerseys during the experimental period. A comparison of the two rations fed is shown in Table 1.

TABLE 1.—Comparision of the Complete (Corn Silage-Concentrate) Ration vs. Control (Alfalfa Hay-Concentrate) Ration.*

	Complete (Corn Silage-Concentrate) Ration	Control (Alfalfa Hay-Concentrate) Ration
Dry matter (%)	38.9	88.0
Concentrates in ration (%)	64.1‡	28.8
Roughage in ration (%)	35.9	71.2
Roughage per concentrate consumed*	1.00:1.79	2.56:1.00
TDN (%)	65.8	59.3
Est. net energy (therms per 100 lb)	70.2	51.4
Digestible protein (%)	10.5	12.8
Total protein (%)	13.9	17.1
Calcium	0.59	1.02
Phosphorus	0.44	0.33
Ca:P ratio	1.34:1.00	3.09:1.00
Nutritive ratio†	1.00:5.27	1.00:3.63

*Dry matter basis — digestibility estimated from Marrison, Feeds and Feeding, 22nd ed.
†% TDN — % digestible protein ÷ % digestible protein = nutritive ratio.
‡Includes the corn kernels in the silage.

RESULTS AND DISCUSSION

The performance of the calves fed the two rations is shown in Table 2 and Figure 1. Analysis of variance showed that the higher dry matter intake of the calves fed the control ration was significantly different. However, body weight gains of the calves fed the complete ration (Table 2 and Figure 1) were approximately equal to those fed the control ration (differences not statistically significant), despite the lower dry matter intake. This was explainable on the basis of the estimated net energy intake, which was more nearly equal for the two rations (differences not statistically significant), than either dry matter intake or TDN intake (Table 2).

The higher net energy of the complete ration was largely the result of its higher proportion of grain concentrate (64.1 percent, including the corn kernels in the silage) compared to 28.8 percent concentrate in the control ration. The calves, however, were able to eat enough additional dry matter free choice in the form of the control ration to approximately equalize the net energy intake and they grew at about the same rate as the calves fed the complete ration. The data on dry matter and TDN intake compared to net energy intake relative to body weight gains for the two rations (Table 2) provide a good example of why net energy is a better basis than either dry matter or TDN for comparing rations widely different in roughages and concentrates.

Although the differences in average gain in withers height were not statistically significant, these differences and the differences in net energy

TABLE 2.—Performance of Calves Fed Complete (Corn Silage-Concentrate) Ration vs. Control (Alfalfa Hay-Concentrate) Ration.

	Complete (Corn Silage-Concentrate) Ration		Control (Alfalfa Hay-Concentrate) Ration	
	Holstein (14)	Jersey (8)	Holstein (16)	Jersey (6)
Dry matter intake, 17-26 weeks (lb.)	559*	409*	714*	524*
Est. TDN intake, 17-26 weeks (lb.)	368	269	424	311
Est. NE intake, 17-26 weeks (therms)	392	287	367	269
Initial body weight, 17 weeks (lb.)	245	153	269	154
Body weight, 26 weeks (lb.)	386	253	407	253
Body weight gain, 17-26 weeks (lb.)	141	100	138	99
Av. daily gain, 17-26 weeks (lb.)	2.24	1.59	2.19	1.57
Initial withers height, 17 weeks (in.)	35.8	31.3	35.4	31.1
Withers height, 26 weeks (in.)	39.8	35.6	39.7	35.9
Gain in withers height, 17-26 weeks (in.)	4.0	4.3	4.3	4.8
TDN/inch gain in withers height, 17-26 weeks (lb.)	92 0	62.6	98.6	64.8
NE/inch gain in withers height, 17-26 weeks (therms)	98.0	66.7	85.3	56.0
TDN/lb. gain, 17-26 weeks (lb.)	2.61	2.69	3.07	3.14
NE/lb. gain, 17-26 weeks (therms)	2.78	2.87	2.66	2.72

*Differences between means within breeds are statistcally significant.

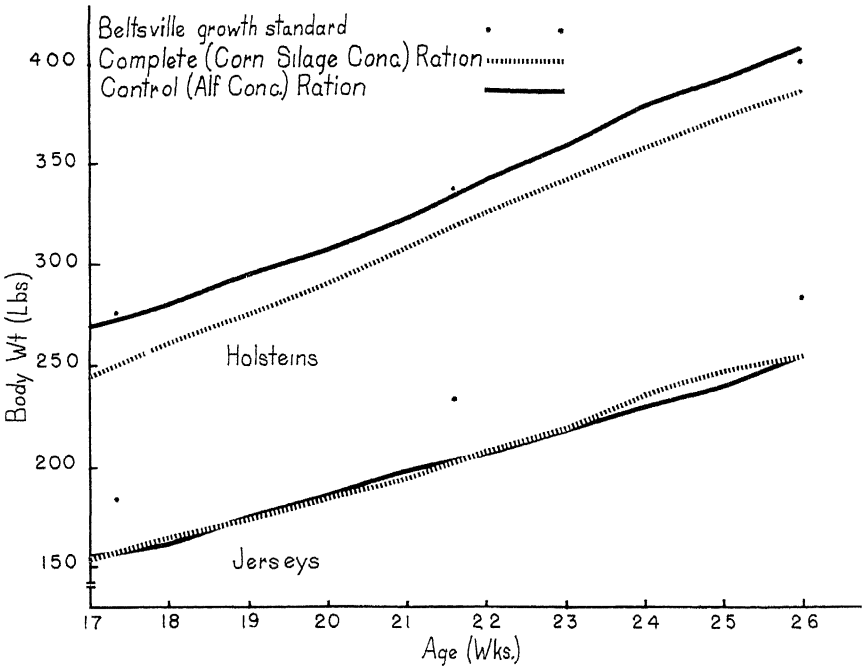

Fig. 1.—Body weight gains of Holstein and Jersey calves fed either the alfalfa control ration (28.8 percent concentrate) or a complete corn silage ration (64.1 percent concentrate) free choice from 17 to 26 weeks of age.

required to produce an inch of gain in withers height suggest that the body weight gains of the calves fed the complete ration were due more to body fat and less to skeletal growth. It is concluded that body weight gain in 4 to 6-month-old calves fed corn silage free choice in a complete ration containing 64 percent concentrates (including the corn kernels in the silage) can be expected to be similar to that obtained when a ration of good alfalfa hay is fed with 29 percent concentrates, assuming adequate protein and minerals are provided.

REFERENCES

1. Addanki, S., J. W. Hibbs, and H. R. Conrad. 1966. High roughage system for raising calves based on the early development of rumen function. XI. Performance of calves fed alfalfa, beet pulp, or soybran flakes as the roughage in complete pelleted rations. J. Dairy Sci. 49: 976.

2. Addanki, S., J. W. Hibbs, and H. R. Conrad. 1966. High roughage system for raising calves based on the early development of rumen function. XII. **In vivo** and **in vitro** changes in rumen contents of calves fed alfalfa, beet pulp or soybran flakes as the roughage in complete pelleted rations. J. Dairy Sci. 49: 982.

3. Conrad, H. R. and J. W. Hibbs. 1956. A high roughage system for raising calves based on the early development of rumen function. VII. Utilization of grass silage, pasture and pelleted alfalfa meal. J. Dairy Sci. 39: 1170.

4. Conrad, H. R., J. W. Hibbs, and Norma Frank. 1958. A high roughage system for raising calves based on the early development of rumen function. IX. Effect of rumen inoculations and chlortetracycline on rumen function of calves fed high roughage pellets. J. Dairy Sci. 41: 1248.

5. Hibbs, J. W. and H. R. Conrad. 1958. A high roughage system for raising calves based on the early development of rumen function. VIII. Effect of rumen inoculations and chlortetracycline on performance of calves fed high roughage pellets. J. Dairy Sci. 41: 1230.

6. Hibbs, J. W., W. D. Pounden, and H. R. Conrad. 1953. A high roughage system for raising calves based on early development of rumen function. I. Effect of variations in the ration on growth, feed consumption and utilization. J. Dairy Sci. 36: 717.

7. Kesler, E. M., J. M. Wilson, and W. H. Cloringer. 1960. Corn silage vs. mixed hay as roughage for Holstein calves. J. Dairy Sci. 43: 298.

8. Sykes, J. F., H. T. Converse, and L. A. Moore. 1955. Comparison of alfalfa hay and alfalfa silage as roughage for growing dairy heifers in a limited milk and grain system. J. Dairy Sci. 38: 1246.

9. Thomas, J. W., J. F. Sykes, and L. A. Moore. 1957. A comparison of alfalfa hay and wilted alfalfa silage as roughage for growing dairy calves. J. Dairy Sci. 40: 626.

10. Thomas, J. W., J. F. Sykes, and L. A. Moore. 1959. Comparison of alfalfa hay and alfalfa silage alone and with supplements of grain, hay or corn silage for growing dairy calves. J. Dairy Sci. 42: 651.